SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2019
Project Title:	Response of midlatitude weather extremes and mean circulation to surface warming in the OpenIFS model
Computer Project Account:	SPDEKJEL
Principal Investigator(s):	Joakim Kjellsson, Mojib Latif
Affiliation:	GEOMAR Helmholtz Centre for Ocean Research Kiel
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…… ……
Start date of the project:	2018-01-01
Expected end date:	2019-12-31

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	8000000	2700325	8000000	0
Data storage capacity	(Gbytes)	2250	28	2250	0

Summary of project objectives (10 lines max)

Our project focuses on how the midlatitude atmosphere responds to surface forcing. Our proposal outlined a suite of simulations using various surface forcings, e.g. remove Arctic sea-ice, uniform surface warming by various amounts etc.

Summary of problems encountered (10 lines max)

So far we have performed fewer simu- lations than expected. The main reason for this is that the lead investigator, Joakim Kjellsson, took up a new position at the end of 2019 which left little time to set up and carry out new simulations in late 2019 and early 2020. Addi- tionally, the COVID-19 outbreak disrupted normal work which also lead to less time being available for new simulations to be designed and made. However, we are committed to carry out the remaining simulations before the end of this year.

Summary of plans for the continuation of the project (10 lines max)

The surface forcing for OpenIFS, i.e. SST and sea-ice fraction, is contained in a grib file prepared by OpenIFS support team using prepIFS. We developed a set of scripts that allows us to take any SST and sea-ice fields and replace the data from prepIFS with our own data. In the end we decided to use the PAMIP (Polar Amplification Model Intercomparision Project) forcing data (Fig. 1) which uses surface forcing from year 2000 with some modifications (Smith et al., 2018). This also allows us to compare our results with the outcomes of that project.

List of publications/reports from the project with complete references

……
……
……
……

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

(see attached document)

Filename: sp_progress_report(1).docx
Directory: /Users/jkjellsson/Library/Containers/com.microsoft.Word/Data/Documents
Template: /Users/jkjellsson/Library/Group Containers/UBF8T346G9.Office/User Content.localized/Templates.localized/Normal.dotm
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ECMWF Special Project "SPDEKJEL" progress report 2020

Joakim Kjellsson

June 2020

1 Performed work

The project "SPDEKJEL - Response of midlatitude weather extremes and mean circulation to surface warming in the OpenIFS model" started in January 2019 and is now on its second and last year. So far we have performed fewer simulations than expected. The main reason for this is that the lead investigator, Joakim Kjellsson, took up a new position at the end of 2019 which left little time to set up and carry out new simulations in late 2019 and early 2020. Additionally, the COVID-19 outbreak disrupted normal work which also lead to less time being available for new simulations to be designed and made. However, we are committed to carry out the remaining simulations before the end of this year.

Our proposal outlined a suite of simulations using various surface forcings, e.g. remove Arctic sea-ice, uniform surface warming by various amounts etc. The surface forcing for OpenIFS, i.e. SST and sea-ice fraction, is contained in a grib file prepared by OpenIFS support team using prepIFS. We developed a set of scripts that allows us to take any SST and sea-ice fields and replace the data from prepIFS with our own data. In the end we decided to use the PAMIP (Polar Amplification Model Intercomparision Project) forcing data (Fig. 1) which uses surface forcing from year 2000 with some modifications (*Smith et al.*, 2018). This also allows us to compare our results with the outcomes of that project.

We were given preliminary access to OpenIFS cycle 43 release 3 in late 2019 and performed some test simulation at a local HPC in Göttingen, Germany. The results showed some differences between 40r1 and 43r3, but the main biases largely remained the same. In particular, the precipitation biases when compared to the GPCP data set remains more-or-less the same in 43r3 as in 40r1 (Fig. 2).

Together with the Alfred-Wegener Institute of Polar Research (AWI), we have successfully integrated OpenIFS into the ESM-Tools workflow manager (*Barbi et al.*, 2020) which handles preparation of input data, execution of the model, post processing of the data to regular grid and netCDF, etc. ESM-Tools

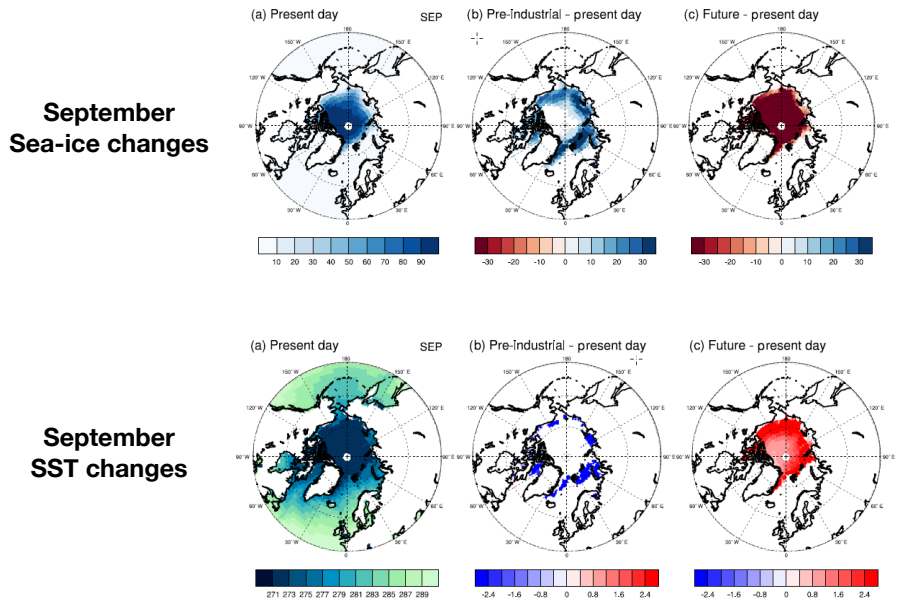

Figure 1: Examples of SST (lower) and sea-ice (upper) fields from the PAMIP forcing data set (*Smith et al.*, 2018).

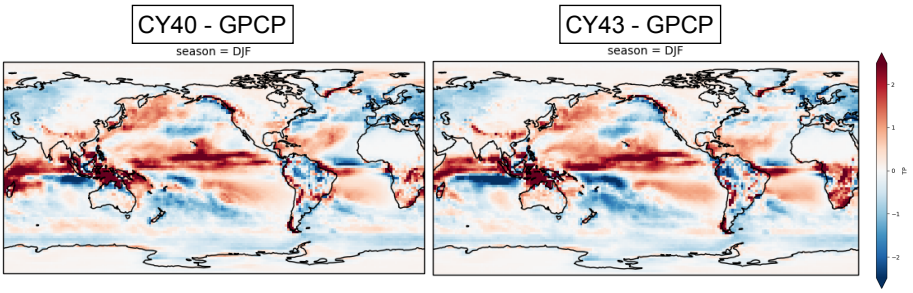

Figure 2: Model precipitation in DJF in OpenIFS cycle 40 release 1 and cycle 43 release 3 (preliminary release). Both runs use data from prepIFS in 1982-1987 and a resolution of T159L91 (linear grid, N80).

allows for easy porting of the model to other HPCs and will hopefully lower the technical barrier for new OpenIFS users.

2 Future plans

We aim to conduct the remaining of our proposed simulations before the end of this project in December 2020. Nearly all preparation work is done and the bulk of the simulations will be done during the summer to late summer. We will use OpenIFS cycle 43r3 for the remaining simulations since they show very little difference to 40r1 in terms of biases etc, but 43r3 has been modified by AWI to use the CMIP6 forcing for greenhouse gases etc.

References

Barbi, D., N. Wieters, P. Gierz, F. Chegini, S. Khosravi, and L. Cristini (2020), ESM-Tools Version 4.0: A modular infrastructure for stand-alone and coupled Earth System Modelling (ESM), *Submitted to Geoscientific Model Development.*

Smith, D. M., et al. (2018), The Polar Amplification Model Intercomparison Project (PAMIP) contribution to CMIP6: investigating the causes and consequences of polar amplification, *Geoscientific Model Development Discussions*, pp. 1–42, doi:10.5194/gmd-2018-82.